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ABSTRACT

Based on the theory that a story's coherence depends directly on the causal cohesiveness of the story's individual events, this paper describes (1) a process by which readers use causal reasoning to connect events, (2) what memory representations result from this reasoning, and (3) the implications of test data on causal reasoning. Following a definition of causality, including the features deemed necessary for judging the existence of a causal relation between two events, a general model for comprehension and inferences of relation between events is sketched. The application of this analysis to stories is then illustrated on a set of data used by N. Stein and C. Glenn in their 1979 study of children's comprehension and recall. The data show striking linear relations between degree of recall and the percentage of story events in the causal chain, thereby supporting the argument that memorability of a story depends upon causal cohesion among events. (RL)

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CAUSAL COHESION AND STORY COHERENCE

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In reading or listening to narratives such as stories, what do children learn or acquire? In terms of content, they may acquire knowledge about human personal problem-solving, about social interaction, about human intentionality, about feelings, about values, about morals, about myths, and about history. However, in order to acquire this knowledge, they must come to understand the individual events portrayed in the story and they must organize and store these events in a memory representation which allows them to retain and draw upon that knowledge for other purposes. The extent to which they find this prerequisite understanding and representation easy to accomplish is directly dependent upon the coherence of the story in question. This coherence, we shall argue and provide evidence for, depends directly upon how potentially cohesive, logically and causally, the individual story events are to one another. The more cohesive are the elements, the more easily will the child find relationships between the events and construct a coherent representation.

The attempt to understand an event is an attempt to discover the causes (that which produces the event) and effects (the events that result from it). Discovering the causes and tracing the consequences of events leads to an experience of a sequence of events rather than a disconnected series. This impression of connectivity extends to events expressed in discourse where we interpret or generate a series of utterances that are related in some manner.

Causal connections between events in stories play a role in a variety of models for representing stories. Notably, the construction of causal event chains is central to Schank's (1975; see also Lehnert, 1978) view of memory for narrative events and the kinds of causal connections identified

by Schank were elaborated upon in taxonomies of inferences in discourse by Trabasso and his co-workers (Nicholas & Trabasso, 1981; Trabasso, 1981; Trabasso & Nicholas, 1981; Warren, Nicholas, & Trabasso, 1979).

In story grammars, the representation of the story was initially depicted by Rumelhart (1975) in terms of syntactic and semantic components. The syntax of the grammar involved categorization of events and a set of rewrite rules for combining and sequencing the events, the semantic component comprised the possible temporal, co-occurrence and causal relations between categories. These components were synthesized in the models of Mandler and Johnson (1977), Stein and Glenn (1979), and Thorndyke (1977).

Finally, the notion of causal chaining of events into sequences played a central role in two approaches to story representation, namely Black and Bower's (1980) model on transition-state hierarchies and Omanson's (in press) decomposition of stories into goal-outcome sequences.

Although all of these approaches assumed that causal relations existed, only Black and Bower (1980) and Omanson (in press) examined the implication for event memory of causal paths through the story. The problem with the latter approach lies mainly in the use of intuitive definitions of causation, the lack of explicit and logical criteria for deciding whether or not a causal relation exists between two events, and criteria for opening and closing the causal chain. Finally, the causal sequence of events in all of the above analyses is decidedly <u>linear</u> in time. Causal chains are more likely to form networks rather than linear orders since causes are disjunctions or conjunctions of sufficient conditions rather than single causes (Mackie, 1980).

We shall, then, describe the process by which the comprehender uses causal reasoning to connect events, what memory representations result from this reasoning and test their implications against data. To do all of these things, we shall first define how causality and meaning are related. Then we sketch what features of a theory of causation seem to be needed in order to have logical criteria for judging the existence of a causal relation between two events. The definition and criteria are drawn from writings on causation by legal theorists (Hart & Honore, 1959) and philosophers (Mackie, 1980). Following our definition of causality, a general model for comprehension and inferences of events relations is sketched. The application of this analysis to stories is then illustrated on a set used by Stein and Glenn (1979) in their study of children's comprehension and recall.

Once the event relations are found on judgmental and intuitive grounds, they are tested using criteria of logical necessity and sufficiency. Then, all the events are represented into a causal network with the conceptualizations of the events as nodes and the inferences as arcs. Given the causal network, a causal chain of the important events in the story is found, using criteria for beginning, continuing and ending the chain. Causal cohesion for a story is then quantified in terms of the percentages of events in the story which are contained in the causal chain and as the percentage of events with causal chain connections. These measures of cohesion are then interpreted as predictors of several sets of data obtained by Stein and Glenn (1979) on fifth grade children, namely immediate and delayed recall of events that are contained or not in the causal chain, conditional probabilities of event recall, recall of events

over stories that vary in causal cohesion, recall of story grammar categories, importance judgments on events and answers to Why questions.

Cohesiveness

Cohesiveness of the events in a story is determined at the level of event meanings where meaning includes both the underlying conceptualization of the event itself and the event's causal or logical relations to other events (Dewey, 1963/1933; Hospers, 1967). Events are states or actions, usually involving one predicate and its arguments. Linguistic cohesion such as anaphoric or cataphoric reference and lexical co-reference (Halliday & Hasan, 1976) are assumed to be used by the comprehender to relate sentences but their connectivity is finally determined by whether or not an event can be causally inferred from another event, using world knowledge about the events.

Causality

Causal statements relating two events, A and B, are made in some context, against a background which includes the abduction by the comprehender of a causal field (Mackie, 1980). Cause and effect are seen as differences or changes within a field and anything that is assumed but is unstated is a condition and not a cause. The causal field or a nexus of causal fields is generated by the comprehender mainly from setting statements which introduce protagonists, give background information, and provide information on location and time. These relevant factors of the causal field are referred to by the phrase, in the circumstances, by which we mean the circumstances of the story established in the mind of the comprehender.

Once we determine a possible world, to say that A causes B means that A and B are changes which occurred or which are differences such that A

was necessary in the circumstances for B. When B occurs, A is necessary in the circumstances for B since if A did not occur, then B would not have occurred. This counter-factual reasoning constitutes a logical entailment of the comprehender's inference that B is causally related to A and constitutes our formal criterion or test for judging that a relation between A and B is causal.

In Mackie's (1980) view, the distinguising feature of a causal sequence is the combination of necessity-in-the-circumstances with causal priority. The core of the notion of causal priority is that the world established in the story has some way of running on from one change to another. Causal priority is associated with both necessity and sufficiency.

1. A is sufficient for B in the circumstances and causally prior to B provided that if A is put into the world in the circumstances and the world runs on from there, B will occur.
2. A is necessary in the circumstances for B and causally prior to B provided that if A were kept out of the world (in the circumstances referred to) and the world were allowed to run on from there, B would not occur.

Model for Comprehending Events as Causal Relationships

When the comprehender hears or reads a story, we suppose that he or she assumes one or more causal fields whose nexus serves as a possible world in which the story events can occur. (Similar views may be found in Collins, Brown, & Larkin, 1981; Wilensky, 1978). These causal fields, as indicated above, are mainly inferred from content contained in setting statements, although each event may alter the causal field by bringing in new relevant factors not previously anticipated (e.g., another protagonist does something to the main protagonist). When more than one causal field

is established (e.g., birthday party, father, little girl), their intersection is found and establishes the background conditions or circumstances in which the story events (changes in states and actions) occur. The comprehender's task is now, like that of an historian (Fischer, 1970), namely, to establish the facts and to order them into a causal chain (in the circumstances). The comprehender sets up general expectations since he or she most often lacks knowledge about all the necessary and sufficient conditions to predict events; upon occasion, the necessary and sufficient conditions are known, and specific events predictions are made. However, the comprehender is generally uncertain and waits for each event to be told before making causal inferences. Given a new, focal event, the comprehender instantiates an expectation by a backward inference from the focal event to those events which are causally prior to it. The processes of expectation, prediction and instantiation are achieved by our naive theories of psychological and physical causality (Wilks, 1977). This knowledge of the world is sufficient to generate causal fields, i.e. specify the relevant factors and generate expectations. In the absence of such knowledge, the comprehender may use contiguity of events in space and time as a basis for making a causal inference (Mackie, 1980).

Once events are intersected as causal fields or have been instantiated by inferences, they become linked together into a causal network. This network serves as but one possible representation of the story since other representations can be derived from it, depending upon considerations of point of view (Wilensky, 1978). Here the notion of a causal chain (cf. Black and Bower's, 1980, critical path or Omanson's, in press, causal-purposeful chain) becomes of value.

The comprehender determines which events enter into the causal chain by (1) selecting statements which open the causal field, (2) tracing links between the causal field statements and subsequent events as long as links to other nodes exist (i.e., expectations continue and are instantiated), and (3) closing the field when there are no more expectations.

At this point, the notion of story schema becomes useful. In the story grammars cited above, setting statements allow episodes to occur. This is analogous to our assumption about how setting statements established causal fields and expectations. That is, they are used by the comprehender to establish the circumstances (assumed but unstated conditions) or possible world in which the story occurs.

The causal chain, then, is opened by setting statements which are causally linked to other statements. Then, once the nexus of these causal field statements is found, differences or changes in the causal field occur which can be explained causally in the circumstances. In the story grammars, there are usually initiating events such as actions on the part of others or nature towards the protagonist, changes in state in or perceptions by the protagonist. These events are more obviously causal than are setting statements and entail a cause versus condition contrast. Once events occur, however, they in turn establish expectations (or predictions) and are instantiated against other events. Goals (reflecting changes in state) are frequent in episodes where the protagonist's actions are under his control and may often be the first event following causal field statements (Stein & Policastro, this volume). Since the pathways away from an event occur often in parallel through the network, some pathways may terminate while others continue. Those pathways which do not continue and which

do not lead to goal satisfaction (or failure), are regarded as "dead-end" (Schank, 1975) chains. Thus, we distinguished between events which are "causal chain events" and events which are "dead-end." Causal chain events essentially focus on a series of explicit or overt goal-directed states and actions; dead-end events are typically reasons for actions expressed as cognitions or goals or emotional reactions which have no further consequences. The identification of causal chain and dead-end events is a procedure by which the comprehender edits or revises the original causal network into other network representations for purposes of recall, summarization or judgments or for determining important or main ideas.

Once the episode is running, the question is: how does it end? Since the causal reasoning is driven by expectations, one answer is to stop when no further expectations occur. This does not suffice since "dead-end" chains lead to no further expectations. Here, the basic episodic structure of the story grammars plays a role. The episode(s) (i.e., causal chain) ends when the desired state of change occurs or clearly fails. In most stories, goals are satisfied and when goal-satisfaction occurs, the protagonist engages in no further action. Thus, consequences which entail goal satisfaction (Omanson's "purposes") are identified for purposes of completing the chain. Goal failures usually result in further consequences, either to the protagonist or to others. These, however, establish further expectations which are not specified in the story. Here, we shall assume that the chain ends with the subsequent, overt consequences to others and to the protagonist.

Application of the Causal Analysis

The above analysis was carried out on the four stories used by Stein

and Glenn (1979). These stories are respectively summarized in Tables 1-4 and their respective causal inference networks are shown in Figures 1-4.

The first step in the process is to identify causal field statements. These are, as indicated previously, typically setting statements. In Story 1, Epanimondas, the causal field is established by statements (1) and (2). The nexus of the causal field is given as an intersection ($\cap$) between causal field statements, e.g., (1) $\cap$ (2) in Story 1 (see Figure 1). There are no other such statements in Epaminondas. However, in Story 2, The Tiger's Whisker, statements (1), (3), (6), (10) and (17) are causal field statements which specify the protagonist, her state of fear of tigers, the state of her husband's health, and her knowledge about tigers' likes and needs. These establish conditions for much of the action in the story. Statement (17) is a causal field statement that is relevant to the tiger's point of view and establishes conditions for his desire to have contact with others. In Story 3, the initial statements (1) and (2) set up causal fields about foxes, bears and the existing friendship between a fox and bear. Statement (16) provides a temporal information and intersects an event with a concurrent event. In Story 4, the statements establish a birthday party (1) and the fact that the protagonist is a young girl (2).

We also used the intersection ($\cap$) symbol to link statements that were tautological to other statements or were continuations of concurrent events. Statement (9) is a continuation of (6), as is (18) a continuation of (17).

Given the causal field statements that open the story, each of the subsequent statements is read in terms of whether it instantiates some

expectation of the previous statements. When an instantiation is found to a prior event, an arrow is drawn from that event back to the event which is causally prior to it. Thus, in Story 1, the existence of the little boy sets up expectations such as he has a mother. In (3), his mother tells him to do something. We are not given the reasons for her act but we can make the inference, (3) $\longrightarrow$ (1), since if the little boy did not exist, then his mother could not tell him to do something within circumstances. Statement (4) is inferred from (1) and (3), (4) $\longrightarrow$ (1) and (4) $\longrightarrow$ (3), since he is little (and makes mistakes) and she wants the cake to get there safely. If he weren't little (and capable of making mistakes) and if she didn't tell him to carry the cake to his grandmother's, she would not, in the circumstances, tell him to be careful with the cake. Statements (6) and (7) can be inferred from (3) alone since these are actions carrying out his mother's directive. They would not have occurred if she didn't tell him to carry the cake to the grandmother. Statement (3) is sufficient in the circumstances for statements (6) and (7) since the possible world runs on from (3) to (6) and (7). Statement (6) predicts (9) and (9) can be inferred from (6) since (6) is sufficient for (9) and (9) would not have occurred if (6) did not happen. Statement (11) is inferred from (12) even though (12) occurs after (11) in the story since (12) contains the reasons for (11). If the reasons did not exist, (11) would not have happened in the circumstances. Given the full list of events and their relations, causal networks such as those depicted in Figures 1-4 are then constructed.

The events in the causal chain are then identified by opening the causal field and tracing pathways to goal outcomes and their consequences to other protagonists or failed goal consequences. In Story 1 both (1)

and (2) are in the causal field nexus and are in the chain since both lead to instantiated expectations that continue until the field is closed. Statement (21) is a consequence of a failed attempt and closes the field. From (1) and (2) through to (21), statement (4) is a dead-end event which has no instantiated expectations. Statements (5), (12) and (22) have no causes and are reasons for events on the chain.

It will be noted that dead-end events in the stories are (a) unmotivated or uncaused reasons for events, (b) emotions, (c) cognitions, and (d) minor settings such as temporal relations, which have no instantiated expectations. In order to get a sense of the causal chain as a story summary, read the circled events for each story.

In our analyses, two judges independently scored the event relations. For the four stories, 148 relationships were identifed and the two judges agreed on 92 per cent of the judgments. Disagreements were resolved by discussion and application of logical necessity criteria.

Implications

Recall of events. If the comprehender represents the story as a causal network of events and their relations and if events are separable into causal chains and dead-end paths, then one might expect events on the causal chain or those events with more causal connections, to be better recalled. The latter predictions follow from considerations of both encoding and retrieval. The likelihood of connecting events during encoding depends upon the number of possible causal connections an event has in the circumstances. In retrieval, the likelihood of finding an event should increase given more pathways to the event. The causal chain expectations result from further operations upon

the initial causal network. Here an editing process occurs where dead-end events are deleted and hence less likely to be entered into a new representation and to be recalled.

In their study, Stein and Glenn (1979) had two groups of 12 fifth grade children listen to and recall subsets of two different stories from the set of four analyzed above. The children recalled each story twice, once immediately after hearing the story and once one week later. We reanalyzed the recall for these children in terms of whether the events were in the causal chain and as a function of the number of causal connections an event had to other events. These data, presented as percentages of recall, are shown in Figure 5.

Insert Figure 5 about here

The most striking result in Figure 5 is the large differences in recall between causal chain and dead-end events. In contrast, the number of causal connections lead only to small increments in recall. Finally, over the one-week interval, dead-end events continue to be forgotten while almost no forgetting occurred over the one-week period for events in the causal chain. These data suggest that a causal chain operates as a representation for recall. If the whole causal network was used in retrieval, there should have been a much stronger effect for number of connections and no differences bewteen the dead-end and causal chain events when these events were matched for connectivity.

We explored these implications further by calculating the conditional probabilities of recalling pairs of events where both events were on the

causal chain, one event was on the causal chain or both were dead-ends. Further, we calculated these probabilities for causes conditional on effects and effects conditional on causes. Let C_1 be a cause and C_2 be an effect on the causal chain; likewise let DE_1 be a cause and DE_2 be an effect on a dead-end pathway. Table 5 summarizes our findings for the conditional and unconditional probabilities of these events over the four stories.

Insert Table 5 about here

The first result of interest in Table 5 is that the probability of recalling a causal chain causes or effect was <u>independent</u> of its respective effect or cause. Second, the recall of a causal chain effect was independent of recall of its dead-end cause as was dead-end effects of causal-chain causes. The only results which show an effect of conditional probabilities were those for dead-end pathways. Here, the conditional probabilities were equal and higher than the unconditional recall probability (sign test, $p < .01$).

These data are consistent with the view that causal chains act as <u>units of recall</u> whereas the dead-end events are retrieved associatively via their causal connections (in the original network).

<u>Causal cohesion and story recall</u>. One measure of causal cohesion for a story is the proportion of causal chain events it contains. The more events which lie on a causal chain, the more coherent and memorable should the story be for the comprehender. We calculated the average percentage recall over both time intervals for the events in each of the four stories

studied by Stein and Glenn (1979) and examined the relationships to the percentage causal chain events in the stories. Figure 6 shows the relation.

Insert Figure 6 about here

The data show a striking linear relation between recall and the percentage of causal chain events. These results support our argument that memorability of a story depends upon causal cohesion among events.

Recall of story grammar categories. One well-established fact is that certain story grammar categories are better recalled than others. Across cultures, variation in literacy and the ages of subjects, the order of recall, from high to low, is setting, consequence, attempt, initiating event, reaction, and internal response (Mandler & Johnson, 1977; Stein & Glenn, 1979; Mandler, Scribner, Cole, & DeForest, 1977; Nezworski, Stein, & Trabasso, in press). Despite the pervasiveness of this finding, no satisfactory account has been offered within the framework of the grammars.

One possible explanation is that the categories contain different numbers of events which are in the causal chain and therefore, those categories which are best recalled contain a greater proportion of causal chain events; those less well-recalled contain proportionately more dead-end events. We tested this explanation by using Stein and Glenn's (1979) categorization for each event (listed in Tables 1-4), identifying whether the event was in the causal chain or was on a dead-end pathway in the network and found the proportion of causal chain events for each category. In addition, we found the proportion of causal chain versus dead-end connections for the events

in each category. Finally, we calculated the proportion of events recalled in each category. Figure 7 summarizes graphically the comparisons between these proportions; Table 6 shows the rank orders of the proportions for the categories.

Insert Figure 7 and Table 6 about here .

Figure 7 shows strikingly similar patterns of recall and causal chain proportions over the set of categories. Table 6 shows near perfect rank-order correlations. An event being in the causal chain accounts equally well as the number of causal chain connections for the universal pattern of category recall.

It should be noted, however, that aspects of the story grammars have been used here to define the causal chain. In particular, the beginning of the episodic sequence (settings) was used to open the causal field and events near the end of the chain (consequences) were used to close the field. These assumptions are also to be found in Black and Bower's (1980) definition of a critical path and in Omanson's (in press) central event sequence. The commonality of assumptions about the episodic structure of an event sequence provides some unity between the story grammars which have focussed on the rules and functions of categories and the causal-chain models which have focussed on causal reasoning about events. The episodic structure serves as a kind of macro-structure (Kintsch & van Dijk, 1978) for determining the causal chain in a network derived from a process model which connects events via prediction and inferences based upon content.

Importance of Events

One goal of teaching comprehension is that children learn to identify "main ideas" (Baker & Stein, 1981). Stein and Glenn (1979) asked the children in a second experiment to tell them what was most important, then, what was next most important and then, what was next most important in the story. They report their data (Table 7, p. 104) in terms of the proportion of children reporting events categorized by their grammar. In order to predict these data, we calculated a weighted average for each category by ranking the order of importance requests 1, 2 and 3 and multiplying each rank by the proportion of children offering that category as important to the request. Then, the rank order of these weighted values was found for the categories. We then found the percentage of causal chain events in each category and ranked them. The two sets of ranks are shown in Table 7.

Insert Table 7 about here

The rank order correlation between the ranks in Table 7 is .95. Thus, in judging the importance of an event in a story, children make use of their knowledge that important events lie on the causal chain. The reason that major goals are most important is that they are always on the causal chain (hence the name "major"). Similarly, most consequences are on the causal chain. In contrast, most reactions and "minor" settings are dead-end events. The intuition that something is important must reflect the meaning of an event in terms of its causal relations to other events.

Answering Why questions. One final application of the causal network is to provide a basis for determining answers to Why questions. Why questions

generally request an explanation for an event. In causal chain theories (Lehnert, 1980; Trabasso, 1981), they ask for an antecedent cause(s) for the event contained in the question.

Stein and Glenn (1979), in their second experiment, asked a number of Why questions on statements contained in each story. The Why questions were administered after the requests for important events. They reported their data as probability distributions of categories in response to questions on four types of categories: internal responses, attempts, direct consequences, and reactions. The original data in terms of particular events given as answers were unavailable (Stein, personal communication). Despite exact answers, we attempted to predict the categorized data using the causal network representations in Figures 1-4.

With reference to Story 1, Epaminondas, consider the question, Why did the butter melt? This question focusses on node (19) for the statement, "the butter had all melted." What the comprehender does, in our view, is to first, access the conceptualization expressed in the question (e.g., node 19). Then, he traces the causes via the inference arcs back to events which are causally prior to the queried conceptualization. In the example, nodes (15), (17), and (18) are found. The comprehender then examines the conceptualization stored at each node and decides whether or not the conceptualization is a cause or an enabling condition since the latter are more properly answers to How or When questions rather than Why questions (see Lehnert, 1980; Nicholas & Trabasso, 1981). Thus, (18) "when he got home" is not given as an answer since this is an enablement (as is node 16). The conditions which are jointly necessary and sufficient in the circumstances are (15) "he put it on top of his head" and (17) "the sun was

shining hard." These nodes contain, therefore, causal antecedents and are generated as answers. The general rule is to trace prior causes; if the immediate condition is an enablement, continue the trace. If it is a causally prior condition, generate it as a causal answer. In Stein and Glenn's (1979) terms, a Why question on a direct consequence (19) is answered by a minor setting (17) and an attempt (15). We followed this procedure for each of the 48 Why questions asked by Stein and Glenn. Two questions were on initiating events whose data are not reported by Stein and Glenn and two questions on internal responses could not be answered by content expressed in the story. For the remaining questions, we found the probability distributions of categorized answers for each of the four types queried. Table 8 shows the results of these calculations.

Insert Table 8 about here

The "fit" of the predicted to the observed answer distributions is reasonable, given the fact that we are not predicting exact but categorized answers and the fact that Stein and Glenn included answers outside the stories (Stein, personal communication). Our main failure is to predict the higher proportion of internal responses (presumably goals) which were observed. To the extent we achieved a fit here, the data indicate that these 10 year old children agreed with our judgments as to causal antecedents. A more proper test of the analysis, however, awaits data on exact answers rather than categorized responses.

In overview, we have shown how a causal analysis coupled with more abstract knowledge of the concept of a story (see Stein & Policastro, this volume), can be used to generate causal network representations of stories which predict a variety of measures of comprehension and recall for stories. In particular we gave an account of recall for events and stories where the inclusion of an event or the proportion of events in the causal chain for a story predict recall. Likewise, the differential recall of story grammar categories is nearly perfectly correlated with the proportion of causal chain events in the category. The judged importance of a category was also nearly perfectly correlated with the proportion of causal chain events it contained. Finally, the distribution of categorized events to Why questions on other categorized events was approximated by tracing causes backward from the queried event through the network.

The analysis on conditional probabilities yielded a surprising finding. If the causal network served as a representation for recall, then we should have found some kind of spreading activation effect (Ratcliff & McKoon, 1981) and an increase in the conditional, as opposed to the unconditional recall probabilities (Black & Bern, 1981). However, this was not found. Instead, causal chain events were recalled independently of their immediate causes. The only conditional probability effects were found for "dead-end" events. It is possible, then, that the causal chain representation is a well-formed unit, derived from but functionally independent of the original causal network. We plan to explore these and other findings, on other existing data for story recall (e.g., Omanson, in press).

In the teaching of comprehension of written discourse, teachers and basal readers (Baker & Stein, 1981; Pearson & Johnson, 1978; Johnson & Barrett, 1981) emphasize the identification of main or important ideas, the verification or recall of facts in the story, the temporal sequencing of events and the discovery of cause-effect relations. Of these, the latter seems to be most critical since, as we have shown, all the others may be derived from the causal network and causal chain representations. There are two implications of this argument. First, instruction or assessment of causal reasoning about events (Why, How, What happened, When, etc.) either may promote or diagnose reading comprehension (and subsequent operations such as recall, judgments and other, evaluative or implicational reasoning). Hence teachers and basal readers could give more emphasis to and provide more systematic questioning of causal relations either during or after reading sections of text (cf. Trabasso, 1981).

The explicit coherence of a story, especially for younger readers, should be a primary goal of writers of stories. By this we mean clear, ordered statements of the events so that the events per se are readily understood and their causal relations are easily inferred from the surface order of events. This also means that causal sequences should not be disrupted by introduction of new and irrelevant causal fields or chains or by descriptive detail that is unnecessary to the current chain. Such writing requires the writer to pose questions to him or herself on the logical necessity for events in relation of other events. Beck's and her colleagues' (Beck, McKeown, McCaslin, & Burkes, 1979) analyses of basal readers gives examples from basal readers which fail to meet one or more of these strictures.

Footnote

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Table 1

Text of Story 1: Epaminondas[a]

1. Once there was a little boy
2. who lived in a hot country.
3. One day his mother told him to take some cake to his grandmother.
4. She warned him to hold it carefully
5. so it wouldn't break into crumbs.
6. The little boy put the cake in a leaf under his arm
7. and carried it to his grandmother's.
8. When he got there
9. the cake had crumbled into tiny pieces.
10. His grandmother told him he was a silly boy
11. and that he should have carried the cake on top of his head
12. so it wouldn't break.
13. Then she gave him a pat of butter to take back to his mother's house.
14. The little boy wanted to be very careful with the butter
15. so he put it on top of his head
16. and carried it home.
17. The sun was shining hard
18. and when he got home
19. the butter had all melted.
20. His mother told him that he was a silly boy
21. and that he should have put the butter in a leaf
22. so that it would have gotten home safe and sound.

a. Circled events are events in the causal chain.

Table 2

Text of Story 2: The Tiger's Whisker[a]

1. Once there was a woman
2. who needed a tiger's whisker.
3. She was afraid of tigers
4. but she needed a whisker
5. to make a medicine for her husband
6. who had gotten very sick.
7. She thought and thought
8. about how to get a tiger's whisker.
9. She decided to use a trick.
10. She knew that tigers loved food and music.
11. She thought that if she brought food to a lonely tiger
12. and played soft music
13. the tiger would be nice to her
14. and she could get the whisker.
15. So she did just that.
16. She went to a tiger's cave
17. where a lonely tiger lived.
18. She put a bowl of food in front of the opening to the cave.
19. Then she sang soft music.
20. The tiger came out
21. and ate the food.
22. He then walked over to the lady
23. and thanked her for the delicious food and lovely music.
24. The lady then cut off one of his whiskers
25. and ran down the hill very quickly.
26. The tiger felt lonely and sad again.

a. Circled events are events in the causal chain.

Table 3

Text of Story 3: The Fox and Bear[a]

1. There was a fox and a bear
2. who were friends.
3. One day they decided to catch a chicken for supper.
4. They decided to go together
5. because neither one wanted to be left alone
6. and they both liked fried chicken.
7. They waited until night time.
8. Then they ran very quickly to a nearby farm
9. where they knew chickens lived.
10. The bear, who felt very lazy
11. climbed upon the roof
12. to watch.
13. The fox then opened the door of the henhouse very carefully.
14. He grabbed a chicken
15. and killed it.
16. As he was carrying it out of the henhouse
17. the weight of the bear on the roof caused the roof to crack.
18. The fox heard the noise
19. and was frightened
20. but it was too late
21. to run out.
22. The roof and the bear fell in
23. killing five of the chickens.
24. The fox and the bear were trapped in the broken henhouse.
25. Soon the farmer came out
26. to see what was the matter.

a. Circled events are events in the causal chain.

Table 4

Text of Story 4: Judy's Birthday[a]

1. Judy is going to have a birthday party.
2. She is ten years old.
3. She wants a hammer and a saw for presents.
4. Then she could make a coat rack
5. and fix her doll house.
6. She asked her father
7. to get them for her.
8. Her father did not want to get them for her.
9. He did not think that girls should play with a hammer and a saw.
10. But he wanted to get her something.
11. So he bought her a beautiful new dress.
12. Judy liked the dress
13. but she still wanted the hammer and the saw.
14. Later she told her grandmother about her wish.
15. Her grandmother knew that Judy really wanted a hammer and a saw.
16. She decided to get them for her
17. because when Judy grows up
18. and becomes a woman
19. she will have to fix things
20. when they break.
21. Then her grandmother went out that very day
22. and bought the tools for Judy.
23. She gave them to Judy that night.
24. Judy was very happy.
25. Now she could build things with her hammer and saw.

a. Circled events are events in the causal chain.

Table 5

Summary of Conditional

Probability Results

1. $P[C_2 \mid C_1] = P[C_1 \mid C_2] = P[C] = .79$
2. $P[C_2 \mid DE_1] = P[C_2] = .75 > P[DE_1 \mid C_2] = P[DE_1] = .41$
3. $P[DE_2 \mid DE_1] = P[DE_1 \mid DE_2] = .56 > P[DE_1] = P[DE_2] = .34$

Table 6

Rank Order Predictions of Category Recall

Category	Recall	Rank Proportion Causal Chain	Rank Proportion Causal Connections
Major Setting	1	1	1
Direct Consequence	2	2	2
Attempts	3	3.5	3
Initiating Event	4.5	5	4
Reactions	4.5	3.5	5
Goals	6	6.5	6
Minor Setting	7	6.5	7
Internal Response	8	8	8
Correlation with Recall		.98	.99

Table 7

Predictions of Importance Ratings

Category	Rank Importance	Rank Percent Causal Chain
Major Goals	1	1
Direct Consequences	2	2
Attempts	3	3
Initiating Events	4	5
Reactions	5	4
Minor Settings	6	6

Table 8

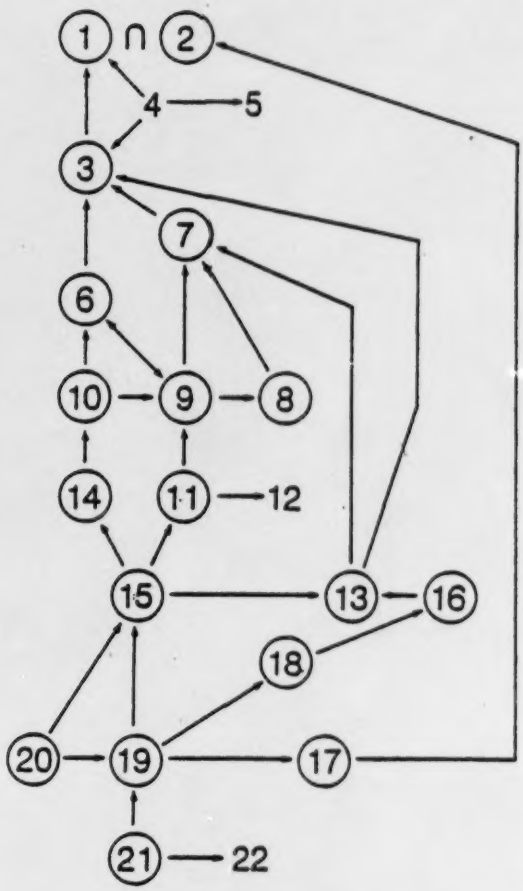
Observed (and Predicted)

Proportion Responses to Why Questions

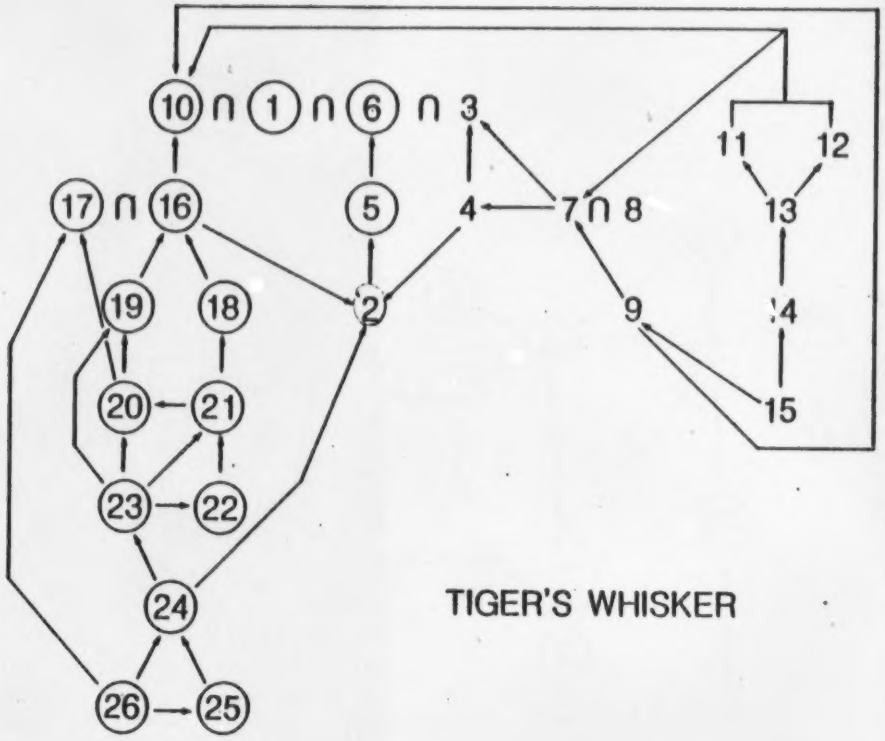
Response Category	Category Probed: Internal Response	Attempt	Direct Consequence	Reaction
Setting	.07 (.07)	.01 (.00)	.13 (.00)	.00 (.00)
Initiating Event	.10 (.21)	.19 (.13)	.09 (.17)	.00 (.00)
Internal Response	.40 (.14)	.55 (.33)	.30 (.33)	.00 (.00)
Attempt	.00 (.07)	.00 (.07)	.00 (.08)	.04 (.25)
Direct Consequence	.00 (.00)	.10 (.13)	.13 (.25)	.52 (.50)
Reaction	.00 (.07)	.12 (.27)	.00 (.00)	.15 (.00)
IE + IR	.16 (.21)	.03 (.00)	.06 (.00)	.00 (.00)
IR + IR	.23 (.14)	.00 (.00)	.20 (.08)	.00 (.00)
DC + A	.00 (.00)	.00 (.00)	.03 (.00)	.29 (.25)
IR + Setting	.04 (.07)	.00 (.00)	.02 (.08)	.00 (.00)
A + Setting	.00 (.00)	.00 (.07)	.04 (.00)	.00 (.00)
Number	? (15)	? (12)	? (12)	? (4)

Figure Captions

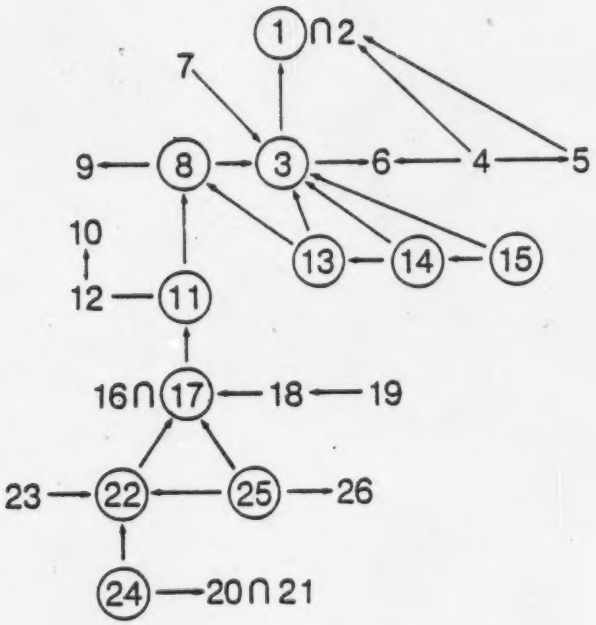
1. Causal inference network of Story 1: Epaminondas
2. Causal inference network of Story 2: The Tiger's Whisker
3. Causal inference network of Story 3: The Fox and the Bear
4. Causal inference network of Story 4: Judy's Birthday
5. Recall of causal chain and dead-end events over time and as a function of the number of causal connections
6. Story cohesion and recall
7. Comparison of percentages of story grammar category reca-1 with causal chain events and connections



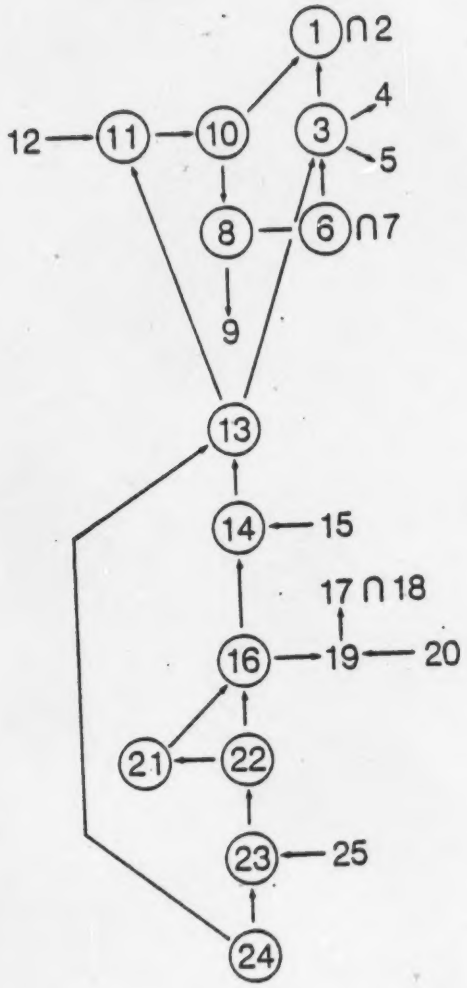
EPAMINONDAS



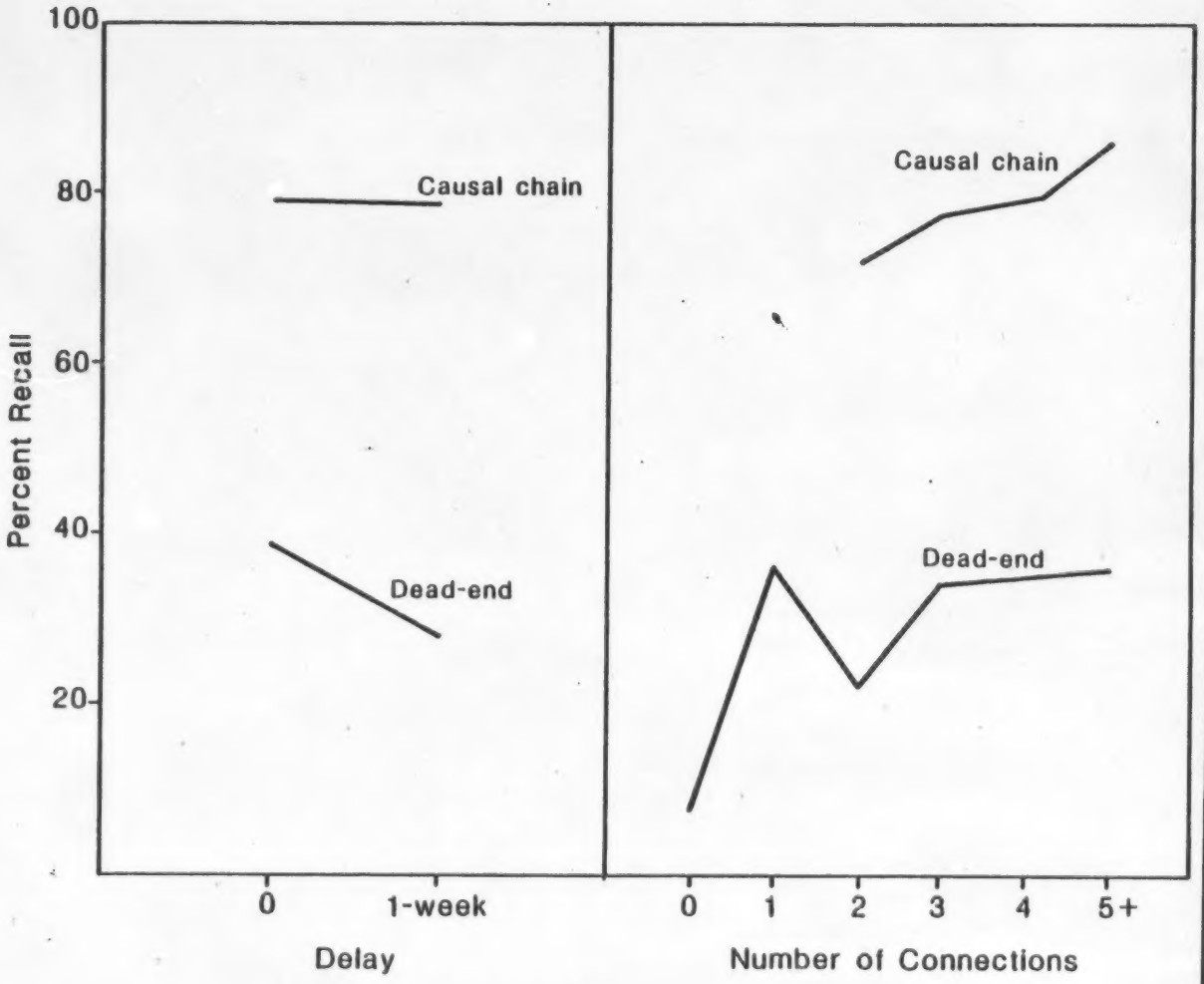
TIGER'S WHISKER

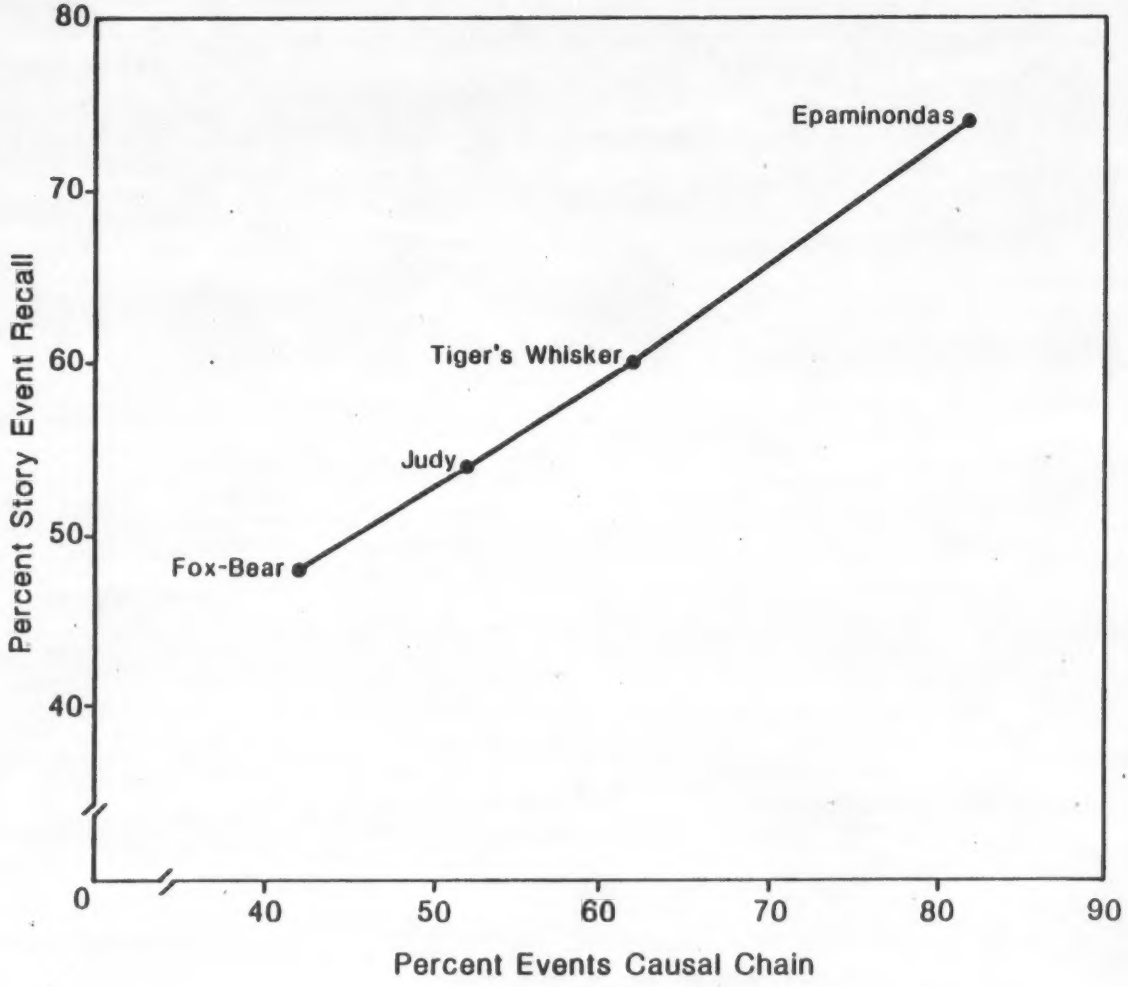


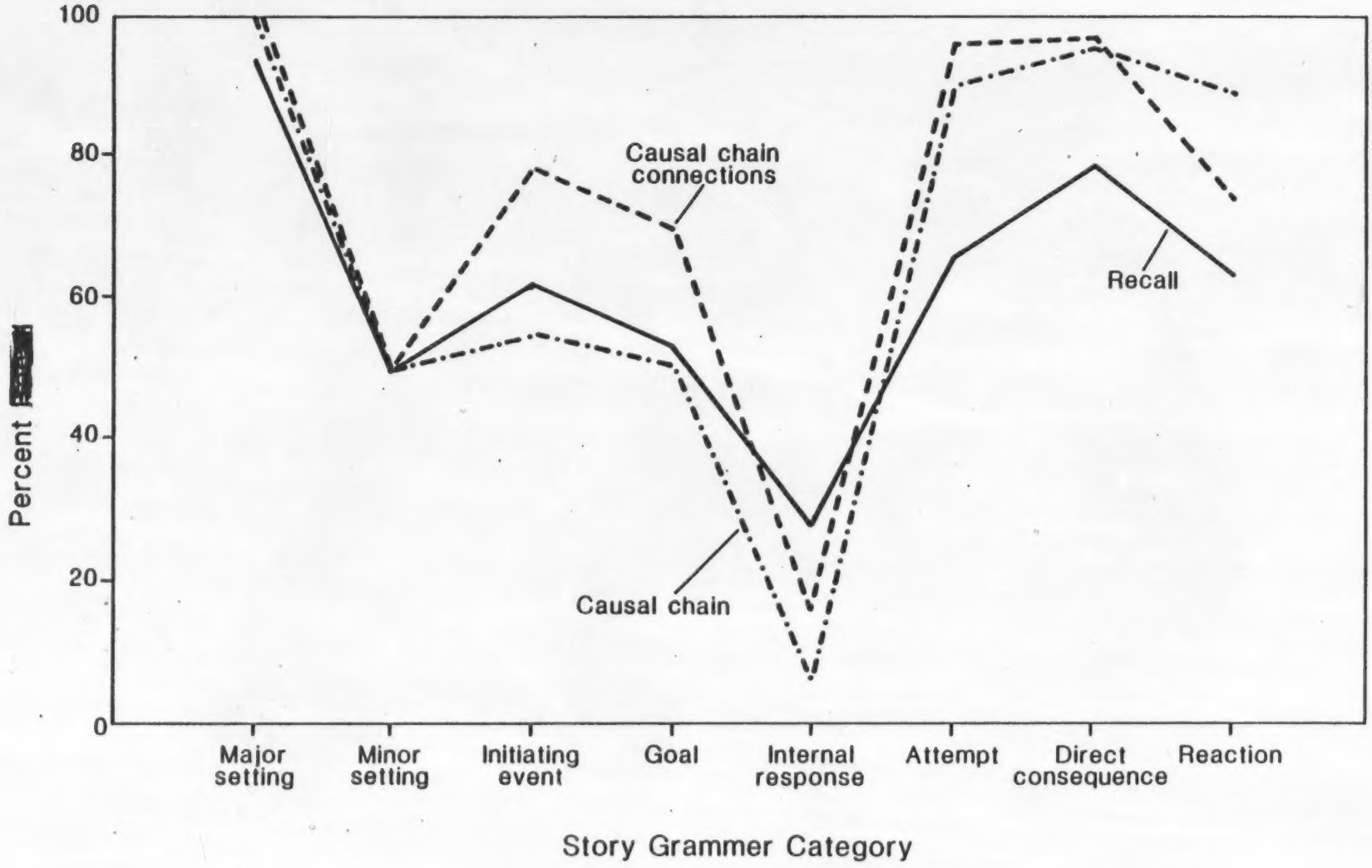
FOX AND BEAR



JUDY'S BIRTHDAY


100
80
60
40
20
Percent Recall
Causal chain
Dead-end
0
1-week
Delay
Causal chain
Dead-end
0
1
2
3
4
5+
Number of Connections


80
70
60
50
40
0
Percent Story Event Recall
Epaminondas
Tiger's Whisker
Judy
Fox-Bear
40
50
60
70
80
90
Percent Events Causal Chain


100
80
60
40
20
0
Percent
Causal chain connections
Recall
Causal chain
Major setting
Minor setting
Initiating event
Goal
Internal response
Attempt
Direct consequence
Reaction
Story Grammer Category